

Remarks

Reconsideration of the present application is respectfully requested. As this response is submitted pursuant to 37 C.F.R. §1.116, entry thereof is respectfully requested. It should be observed that while new claims are added herein, such claims are dependent upon presently pending claims. Accordingly, if favorable consideration was given to the presently pending claims (from which the new claims depend), then favorable consideration should likewise be given to the newly presented claims. Thus, it is submitted that new issues are not per se raised by the claims newly presented herein.

It is submitted that the remaining claims under consideration are in condition of allowance, particularly in view of the following remarks.

All pending claims, namely claims 3-4, 6-7, 13-22, 33, 35-36, and 39 stand rejected under 35 U.S.C. §103(a) as unpatentable over Cadien et al. (U.S. Patent no. 5,516,346) in view of Kaufman et al. (U.S. Patent no. 6,063,306).

The examiner purports that Cadien et al. teaches a concave insulating film formed on a substrate forming a barrier layer, forming an interconnect metal film over the surface, polishing the surface by a first and second polishing process until the surface of the insulating film, other than the concave, is exposed. Also, the examiner purports that Cadien et al uses a polishing slurry comprising silica polishing material, an inorganic salt, and an oxidizing agent.

Concerning Kaufman, et al., the examiner indicates that:

"Kaufman et al. shows applying a first slurry comprising an alkanolamine (such as, triethanolamine) and second slurry comprising carboxylic acid (such as tartaric acid) in a polishing process as well known in the art. Kaufman et al. also teaches the slurry comprising benzotriazole and the barrier film being a tantalum-containing metal film (Abstract, col. 4, lines 15-67, col. 6, lines 2-45, col. 8, lines 20-45, col. 10, lines 50-65, TABLE 1, 4, col. 15, lines 25-65, col. 16, lines 48-67)."

The applicants submit that certain limitations of the invention as claimed herein are not taught or suggested by the prior art references.

Accordingly, it is respectfully observed that:

1. Claims 3 and 6 distinguish over Kaufman, et al. in view of Cadien, et al. in that the interconnect metal film partially remains in the surface (except the concave);
2. There is teaching in Cadien, et al. that its polishing slurry is effective at polishing a substrate having a Ta-barrier layer;
3. Kaufman is deficient as to the time at which the first polishing step is terminated, whereas in claim 13 it is indicated that the interconnect metal film does not remain on the surface (other than the concave), while the barrier metal film is not completely removed by polishing; and
4. The second slurry composition is not taught by the references. For this reason, it is respectfully submitted that the rejections are traversed.

It is observed that:

"To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on the applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). See MPEP § 2143 - § 2143.03 for decisions pertinent to each of these criteria.

The initial burden is on the examiner to provide some suggestion of the desirability of doing what the inventor has done. To support the conclusion that the claimed invention is directed to obvious subject matter, either the references must expressly or impliedly

suggest the claimed invention or the examiner must present a convincing line of reasoning as to why the artisan would have found the claimed invention to have been obvious in light of the teachings of the references.” *Ex parte Clapp*, 227 USPQ 972, 973 (Bd. Pat. App. & Inter. 1985).

As indicated above, and as discussed in greater detail below, certain aspects of the invention as claimed are not taught or suggested by Kaufman, et al. in view of Cadien, et al.

Reason 1

After practicing the first polishing step recited in claims 3 and 6, the interconnect metal film (i.e., Cu-based film) partially remains on the surface in locations other than in the concave portion (see p. 12, line 9 – p. 15, line 24). On the contrary, Cadien et al. discloses that the first polishing step continues until substantially all of the W (tungsten) layer formed on TiN layer is removed (see column 8, lines 17-21).

Kaufman, et al. does not cure this deficiency. Kaufman, et al. does not disclose at what time the polishing step is terminated. For this first reason, it is submitted that claims 3, 6, and the claims which depend from them, are in condition of allowance.

Reason 2

Cadien et al. discloses a polishing slurry comprising an inorganic salt (fluoride salt) employed as a complexing agent to complex with the Ti in a Ti layer (see column 8, lines 53-56). However, in the present invention, Ta is used as a barrier metal, not Ti (see claims 39 and new claim 45). Cadien et al. does not teach that the slurry including the inorganic salt is effective at polishing a layered substrate employing a Ta layer as a barrier layer. For this reason, these claims are in condition of allowance.

Reason 3

As indicated above, Kaufman et al. does not disclose at what time the first polishing step is terminated. As recited in claim 13 of the present application, the first polishing step is conducted such that the interconnect metal film does not remain on the surface except in the concave portion (that is all of the interconnect metal film other than in the concave portion is removed) while the barrier metal film is not completely removed (that is the barrier metal film remains). Cadien, et al. does not cure this deficiency, as it teaches that the surface of the insulating film is exposed (see p.11, supra.). Furthermore, the second slurry used in the second polishing step of Kaufman, et al. has a polishing-rate ratio of the interconnect metal to the barrier metal of 1 or less (see p. 16, line 1 – p. 17, line 23).

When the interconnect metal film remains on the surface other than in the concave portion after the first polishing step, complete removal of the remaining interconnect metal film in the second polishing step is difficult because the low polishing-rate ratio of the interconnect metal to the barrier metal of the second slurry. This may cause problems, such as short-circuit relating to an insufficiently polished part, reduction in throughput because the time period in which polishing is practiced must be longer for preventing the short-circuit, and erosion resulting in an area of already exposed barrier metal or insulating film that was exposed in the first polishing step, due to the longer polishing period. For these reasons, it is submitted that the rejection of claim 13, and the claims which depend from it, are traversed.

Reason 4

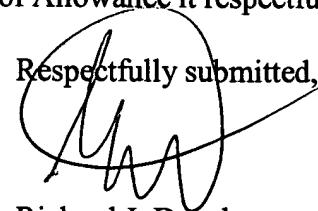
As recited in claims 3, 13 and those claims depending from them, the first slurry, which contains alkanolamine, which may reduce the polishing rate for the barrier metal film while increasing the difference in the polishing rate between the barrier metal film and the interconnect metal film in order to enhance the function of the barrier metal film as a polishing “stopper”. Thus, the interconnect metal film is completely removed without realizing the above noted problems.

Since the barrier metal (Ta-based metal) is chemically much more stable than the interconnect metal (Cu-based metal), a polishing-rate ratio of the interconnect metal to the barrier metal of 1 or less has previously been achieved by reducing the contribution of chemical polishing; that is, by reducing the presence of an oxidizing agent or by adding an antioxidant to reduce a polishing rate for the interconnect metal film. In this technique, a polishing rate for the barrier metal film remains at a relatively low value and tends to produce an insufficiently polished part, which may lead to short-circuiting. On the other hand, an increase in the polishing time for preventing this problem may lead to other problems, such as reduced throughput. Also, excessive strengthening of mechanical polishing may cause problems such as scratches or erosion in the polished surface. Hence, the second polishing step in the second polishing method employs a polishing slurry which can control a polishing-rate ratio of the interconnect metal to the barrier metal to a desired level by increasing the polishing rate for the barrier metal film. Thus, the composition according to claims 16-19 is suited for use as the second slurry (see p. 20, line 19 – p. 21, line 25) where an alkanolamine is employed in the first polishing slurry.

Accordingly, Kaufman et al. is deficient with respect to the time where the first polishing step is ceased in the method of claim 13, nor does it teach the second slurry composition of claims 16-19.

Based on the foregoing, it is respectfully submitted that all the claims of the present application contain patentable subject matter and a Notice of Allowance is respectfully requested.

Respectfully submitted,



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